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DILLON INCINERATION PROJECT

Prepared for

MONTANA DEPARTMENT of NATURAL RESOURCES and CONSERVATION

DILLON INCINERATION PROJECT

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June 1984

Prepared for

Montana Department of Natural Resources and Conservation
1520 East 6th Avenue, Helena, Montana 59620
Renewable Energy and Conservation Program
Grant Agreement Number RAE-468-811

Available from

Montana State Library, 1515 East Sixth Avenue
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INTRODUCTION

With energy prices on the increase, conservation technologies of many kinds are becoming more attractive to residential, commercial, industrial, and institutional energy consumers. Officials of Western Montana College (WMC) in the southwest Montana town of Dillon became interested in the idea of combining municipal solid waste (MSW) with wood residue from a local lumber mill to fuel an incinerator that would produce steam for the campus.

Subsequent research, the findings of the researchers, and their recommendations, together with the material on which they are based, is presented here. This will assist communities with similar requirements and limitations to decide if such a project would work for them.

Shortly after officials of Western Montana College received the report from the engineering firm, a meeting was held to discuss the college's proposed request to the 1983 legislature for long range building funds. The report was considered on the meeting agenda. Those WMC officials present decided not to include a requests for funds for the incineration project in their long range building program.

Officials of Beaverhead County, where Dillon is located, were unwilling to let the project drop---the county was to be a co-sponsor of the project. At a subsequent meeting of the county sanitation board the concerns of the county were voiced: another landfill site must soon be acquired, and the environmental and economic costs would be high. It was pointed out that the use of a waste-burning system at WMC would extend the usefulness of the present landfill significantly--about seven times. Nonetheless, WMC's Fiscal Affairs Director, who was present at the request of the county sanitarian, stated that because the Board of Regents had not recommended funding such a project, the college administration could not actively support it. He did not, however, wish to see all consideration of the project dropped.

In October* the county sanitarian reported to WMC officials that adjoining Madison County was facing closure of an (unlicensed) landfill in the western part of the county. Closure would necessitate hauling solid waste from the towns of Sheridan and Twin Bridges over a mountain pass to Ennis, a distance of over 40 miles. The sanitarian believed that this waste could be used by WMC to fuel an incinerator.

Beaverhead County officials failed in their attempts to introduce a

* 1982

bill into the 1983 legislative session to fund the proposed incineration project. Since the legislative session, Montana State University staff have introduced the subject to the Montana Board of Regents. Western Montana College officials hope that interest at this level may help to obtain approval from the WMC Board of Regents of a WMC request to the 1985 Legislature for the funds needed to build the proposed incinerator.

Meanwhile, Stoltze Lumber Company, which was to have been a source of wood waste for the project, but had been shut down, has resumed production and should be able to supply the incinerator with an alternative fuel in the seasonal absence of an adequate supply of municipal solid waste.

Western Montana College and Beaverhead County officials hope to have an agreement formulated before the 1985 Legislature convenes. Such an agreement would help to demonstrate to legislators that the project has local support.

II. BACKGROUND

Western Montana College is in Dillon, Montana, elevation 5,057 feet, an area that normally has a relatively high (8,002) number of heating degree days (HDD) (65F base) during the annual heating season. The college's 1980 utility record was used as the basis for calculations (see Section VI below). As 1980 had a relatively mild winter, 6,133 HDD, the gas consumption figures were adjusted for that fact. Also considered was the substantial base-load (non-weather related) gas consumption of the campus and the addition of the proposed swim center. The adjusted gas-consumption figures are for a year with winter of average temperatures.

Considering an average day for each month of the year, a figure was derived for millions of BTU's required per day (MMBTU/day) from the adjusted utility use, the higher heating value of the gas at that altitude (0.871 MMBTU/MCF) and the boiler efficiency (0.74) of the college system. The current natural gas price, $4.388, was used throughout the analysis, except for the 1987 and 1992 projections.

Municipal solid waste (MSW) -- garbage -- varies radically in composition and energy content from place to place and time to time. The term is used here to mean the raw garbage as loaded into the packer collecting vehicles, excluding "white goods" -- discarded appliances and similar large incombustible metal objects. Even so, about 15% of the MSW is not combustible; cans, small metal objects, glass containers, and other inerts make up that portion.

The Dillon garbage contractor delivers from six to ten tons per day to the landfill site. The high figure obtains, unfortunately, in the

summertime when energy demands are low; the low figure applies to the coldest winter months. This amount of MSW, averaging 8.17 TPD (tons per day) over the course of the year, averages about 3.59 lb. per person per day. For the energy content of the municipal waste a value of 4,750 BTU/lb. was selected--the appropriate industry figure for predominately residential commercial MSW.

The possibility of hauling garbage to the proposed WMC incinerator from other small, widely separated communities in the county is not a practical consideration.

Supplemental Fuel

A possible source of supplemental fuel for the proposed facility, when steam needs surpass MSW output, is the Stoltze Lumber Company about 8 miles south of Dillon. The plant reopened in the spring of 1983; 8 to 16 TPD of bark and wood waste will be available. The present rate for a loosely packed load 200 cubic feet, or 1 1/2 tons, ranges between $2 and $6. A conservative estimate of daily supply is 10 TPD. (Any further need for fuel will be supplied by the natural gas normally delivered to the campus.)

The wood waste is primarily fir, pine, and spruce bark, which produce respectively 9,962, 9,499, and 8,830 BTU/lb. (Forest Products Laboratory, Madison, WI). Somewhat depreciating these values to allow for the increased moisture content of bark in the field, and for the small admixture of lower (HHV) wood waste besides bark, 9,000 BTU/lb. was used as the HHV of the supplemental wood waste fuel. Burning the bark is not economical if the moisture content is above 55%.

DILLON MSW-------------8.17 TPD-----------LANDFILL

NATURAL GAS---------152 MCF/DAY-----------STEAM

WOOD WASTE----------------10 TPD-----------DISPOSAL

Fig. 1. Present Disposition of Fuels. Wood waste disposal is by means of a teepee burner.

DILLON MSW
8.17 TPD

LANDFILL
1.46
TPD

Proposed WMC
Mass-Burn
Incinerator &
Boiler

15.4
NATURAL GAS
MCF/DAY

STEAM

5.16 TPD
WOOD WASTE

4.84 TPD

DISPOSAL

Fig. 2. Proposed Disposition of Fuels. The landfill would also be needed for the disposal of "white goods" and of such non-combustibles as bricks, concrete, and wallboard.

Alternative Technology

Other possible technologies involve cogeneration. They include the addition of a turbine generator to the MSW incinerator to produce electrical power. Such an installation requires a higher-pressure boiler, as well as electric grid interface equipment with switches and controls, costing about $200,000. Another alternative, a freon system employing a heat exchanger, is also prohibitively expensive. Other more advanced technologies such as refuse-derived fuel have higher efficiency and are low in pollution factors, but have not proved to work well when based on municipal solid waste.

Existing and Proposed Operations

Two mass-burn MSW disposal units are operating in the region, and another is planned. A 72-ton per day (TPD) facility in Livingston, Montana, has been in operation since April 1982 under a contract to supply steam to a nearby Burlington Northern Railroad facility. A primary motivation toward that plant was relieving the county of legal problems with landowners next to the county landfill. In Idaho the Cassia County plant at Burley, processing 50 TPD, generates steam that is sold to the J.R. Simplot Company. A continuously operating facility with a load of 200 TPD is being designed for Pocatello, Idaho.

Buy-back of Electrical Power by Utilities

The possibility of selling to utilities the excess power generated by the incinerator facility is unlikely. Public utilities are required by the 1978 Public Utility Regulatory Policies Act to compute an "avoided cost" based on the rate of the next generating unit online, and to use that rate to buy back electricity from on-site generators like the one proposed at Western Montana College. However, in the western Montana power grid, this rate is low--$0.0234/kWh for short-term contracts and $0.0409 for contracts of over 4 years. (By contrast, the Idaho Public Utilities Commission has mandated a rate of $0.067/kWh for avoided costs and buy-back.) Industry officials consider $0.05 the minumum buy-back rate at which on-site cogeneration is feasible. Extreme caution was urged regarding future prospects for increased electrical buy-back rates (telephone conversation, Ted Otis, Montana Public Service Commission, April 19, 1982).

Additional Considerations

Multiple-stage mass burn technology offers both simplicity and reliability, and so meets the principal criteria of this study. However, the key elements must be considered to make an informed decision to further investigate and eventually construct and operate this project successfully:

1. Funding. Approximately $1,000,000 (1982 $) must be acquired, either through long-range building funds administered through the Montana Board of Regents or through loans or bonds. The basis for that estimate is as follows:

A. Basic Unit

1. Mass-burn incinerator/waste-heat boiler unit (Consumat model C-550 or similar)		$ 475,000
2. Freight for unit		42,000
3. Installation		18,000
Subtotal	$ 535,000	

B. Accessories

1. Water make-up system, de-aerator		36,000
2. Economizer		16,000
3. Spare parts (fan motors, hydraulic lines, switches, thermocouples, etc.)		6,000
4. Recording steam flow meter		3,500
Subtotal	$ 61,500	

C. Associated Structures and Utilities

1. Building to house basic unit and tipping floor, about 3,000 ft2, including site preparation		$ 115,000
2. Steam piping, 8" x 150 ft, and installation		7,500
3. Scale, 70 ft, with digital readout and printer		40,000
4. Shed for scale		4,000
5. Utility hook-ups		2,500
6. Landscaping, outside lighting, soil tests		6,0000
Subtotal	$ 175,000	

D. Rolling Stock

1. Front-loader tractor		$ 18,500
2. Live-bottom trailers (2), used		4,000
Subtotal	$ 22,500	

E.	~~gineering and management fee @ 12.5% of A+B		74,600
	Subtotal	$ 74,600	
F.	Miscellany, contingency, and inflation		$131,400
	Subtotal	$ 131,400	
	TOTAL		$1,000,000

Early placement of an order, together with a 10% to 20% down payment, will assure early delivery (often within twelve months) and guaranteed price on the basic unit. Operating costs and revenues to some participants will be considered below, especially in Section VI.

2. Cooperation. An MSW-to-steam facility at Dillon would be a community project. While Western Montana College would house the facility, own it, and assume the major portion of the risks, the involvement of other participants is crucial to success. Beaverhead County local officials and businessmen and the residents of the area would gain or lose by the success or failure of the operation. Local landfills currently operate at fairly high cost (about $9 per ton), under state variances which cannot be expected to extend indefinitely. New mechanisms for waste disposal are required; burning, if sufficiently pollution-free (as this project would be) provides one obvious solution. Appendix 1 has some data and discussion of the considerable problem of MSW disposal in the outlying areas of Beaverhad County.

Local lumber mills accumulate unproductive wood wastes. A portion of those might be used to generate some income and ease current disposal problems.

Even though there would be more costs in hauling the garbage, wood wastes, and ash residue, the landfill operation could be considerably reduced under this proposal.

An attempt was made to duplicate the major business arrangements and benefits or costs to each major participant in this analysis, but the resulting figures must be considered preliminary. Input data was sketchy, and only one possibility was considered -- wood waste haulage into the facility, and ash haulage out, by Beaverhead County. While the overall feasibility and economic viability of the MSW-to-steam proposal is not directly affected by the business arrangements among the participants, those arrangements are extremely important to future cooperation.

3. Good management. Included here are both day-to-day management of the facility with sufficiently skilled personnel and the planning and scheduling involved in the coordinated deliveries of garbage, wood waste, and residue.

The Table below shows the benefits that would be realized by the college and the county, in 1982 dollars, if the facility were in operation, under several different dates and scenarios. All benefits are relative to the current situation for an average-weather year. Debt service was predicated on a $1,000,000 loan at 11% over 15 years.

Monetary Benefits of Project

Year/Scenario	College	County
1982 with debt service	$ 19,402	$8,543
1982 without debt service	158,467	8,543
1987 with debt service	101,467	8,543
1992 with debt service	201,505	8,543

III. SPECIAL REQUIREMENTS--STORAGE FOR SOLID WASTE

Space and equipment requirements were based on the current municipal solid waste load on the Dillon landfill, which varies between about six and ten tons per day; the average is about 8.17 TPD. Individuals bringing large quantities of non-combustibles take them to the landfill directly; smaller quantities are placed in a dumpster for later transport to the landfill. Under this proposal the waste would be delivered to the WMC facility in packer trucks and dumped onto the tipping floor.

A scale will be necessary to weigh trucks in and out unless business arrangements can be worked out to eliminate that expense.

The storage area required can be calculated approximately as follows:

3 days MSW storage capacity x 10 tons/day maximum probable load x 2000 lb/ton x cuyd/400lbs x 27cuft/cuyd x 1/3.5 hi pile = 1,157 sqft = maximum storage area required.

Even doubling this space to allow for mixing area, room for the front-loader and other equipment and trucks to be parked and maneuvered about the floor still allows almost 700ft2 for the compact incinerator-boiler vertically stacked unit and auxiliary equipment.

The tipping floor must contain heavy-duty industrial type drains connected to the sewer and must be equipped with at least two fire hose connections for nightly wash-down of the tipping floor. Wash-down and ash-quenching water costs about $15 per month; that amount was included in the analysis, with the additional electricity costs of the facility.

The wood waste will be somewhat less dense than MSW (sawdust runs about 325 lb/yd3) and will be stored in a specific area of the floor. When the facility is burning, wood waste storage capacity at the source (mill) eliminates the need for much storage at the incinerator site. CAUTION *The burning characteristics of the proposed wood waste are a source of concern and need to be investigated further. BTU-content, moisture content, the possibility of spontaneous combustion, and the compacting characteristics require investigation.

IV. EQUIPMENT SELECTION CRITERIA; O & M COSTS

The essential selection criteria for the incinerator-boiler unit are:

1. Easy maintenance. While maintenance may be frequent, it should be simple and straightforward. Periodic overhaul should be confined to separated two-day intervals during summer periods of low steam needs. Downtime of unscheduled nature should be no more than 15% to prevent problems with overly long storage of municipal solid waste. Spare parts must be needed infrequently and, preferably, be locally available or stocked in sufficient numbers at the facility to avoid transportation delays.

The maintenance of these units reduces to three primary functions:

a. Periodic cleaning of the boiler heat exchange surfaces.
b. Replacement of hydraulic lines when and if they fall in the loading ram equipment. With inexpensive spares at hand these lines can normally be replaced within 30 minutes.
c. Replacement of electric motors, primarily on fans or blowers moving hot gases through the unit and providing turbulence necessary for complete combustion in the secondary chamber. These can be replaced quickly as long as spares are available on site.

2. Simplicity of operation. Here a packaged unit with integral controls and designed-for-use auxiliary equipment is best. The basic incinerator-boiler unit is simple and rugged and, with the exception of the hydraulic loading rams and drag-chain residue removal apparatus, has few moving parts. All equipment should be obtained from the same supplier to avoid problems with parts replacement.

Five companies identified as potential suppliers of mass-burn technology disposal units are:

1. Consumat System, Inc.
   P.O. Box 9979
   Richmond, VA 23227

2. Environmental Control Products, Inc.
   15 Benton Drive
   P.O. Box 24
   East Longmeadow, MA 01028

   or

   P.O. Box 240707
   Charlotte, NC 28224
   (704) 400-1620

3. Brule D & E, Inc.
13920 South Western Avenue
Blue Island, IL 60406
(312) 388-7900

or

Peter Brennen
Seattle, WA
(206) 575-8033

4. Kelly Co.
Milwaukee, WI
(414) 352-1000

or

Don Johnson
Northwest Handling Systems, Inc.
Seattle, WA
(206) 575-0814 or (800) 562-4968

5. Peabody-Gordon-Platt
Windfield, KS
(316) 221-4770

In the case of larger installations the vendor provides operator training and operates the facility for its first year to eliminate the possibility of excessive damage to the plant (and to the vendor, through their warranty of the facility). While first-year operation will not be practicable for such a small unit located in such a remote place as Dillon, thorough training of one or more operators and an acceptance plan for all the major pieces of equipment and the stack emission levels should be built into the purchase contract.

See Section II for a preliminary breakdown of the initial costs of such a project; the total amount involved is approximately $1,000,000.

V. OPERATION OF THE STARVED-AIR INCINERATOR-BOILER

The two combustion chambers are generally installed with the secondary chamber or afterburner above the primary or gasifer. The fuel (MSW or wood waste) is dumped off the tipping floor from the screw-conveyor or from the bucket of the front-loader at a rate determined by temperature in the secondary chamber during steady-state operation or start-up. During start-up the auxiliary gas-fired burner(s) heat the waste until it is hot enough to sustain combustion to partial oxidation. About 44,000 BTU per ton MSW are consumed, on the average, for auxiliary fuel (natural gas) during start-up and shut-down. See the anlysis in Section VI.

The "starved-air" feature of the primary combustion serves to keep the resulting gas relatively free of entrained particulates and, drawing a partial vacuum off the tipping floor, prevents odors from leaking out of the building.

Gases leaving the primary chamber are at 1200 +/- 100F; flue gas leaving the secondary chamber is at 1800 +/- 100F. These temperatures are sensed by thermocouples activating the auxiliary burners, water mist sprayers, air dampers and fans or blowers controlling the combusion process and maintaining it within a relatively efficient and certainly safe range.

The gases from the secondary chamber pass around the water-filled tubes of the boiler, losing heat to the fluid, and finally exit at a reduced temperature of less than 500F.

As fresh MSW or wood waste fuel is fed in, residue is pushed to the rear of the unit and into quenching water. The wet ash, less than 10% of the volume of the original fuel, is finally trucked to the landfill or, possibly, used for roadbase material. Since the ash is inert. it need not be actually buried in the landfill but can be used instead for cover. Wet ash dries into a cement-like compact mass.

(NOTE: Most units have an auxiliary or "dump" stack constructed to withstand the full 1800F of the hot flue gas, which can be used to shunt these gases past the boiler in case of failure to a boiler component or other need for rapid shutdown of the system.)

Figure 3 shows the thermodynamics of the starved air incinerator-boiler unit and [illegible] mass flows for one pound of MSW. A corresponding diagram for wood waste would have slightly different numbers; we estimate the overall efficiency to by 55% for the bark-burning mode.

MSW 4,750 btu
0.4 lb H_2O
0.13 lb C

Air, 200%
4.3 lb

Primary and secondary
Combustion Chambers

Non combustbles
ash, other losses
12%, 570 btu

0.4 lb H_2O
@1,800F
831 btu

5.4 lb combustion
products 2,136 btu

2.1 lbs Xs air
@1,800F 1,213 btu

0.4 lb H_2O
@500F 515 btu

BOILER

5.4 lb combustion
Products @500F 934 btu

2.1 lb air
@500F 485 btu

Radiation and other
losses 2.5% 104 btu

Steam, 1.83 lb @274F
45 psia, 1,172 btu/lb
2,142 btu
45% efficient

Figure 3. Energy and Mass Flows for Proposed Starved-Air Incinerator Waste-Heat Boiler Unit. The numbers are on the conservative side; some units reduce stack gas temperature to as little as 400F and achieve overall efficiences of as much as 55% or 60%.

VI. ADAPTATION OF REPORT FINDINGS TO A GIVEN COMMUNITY

Other communities with similar needs should consider the following points in deciding whether they would find a MSW incinerator practical.

1. Compare the annual demand for steam and the amount of steam that can be produced by burning the municipal solid wastes and other available waste fuels.

2. Taking a "worst case" summer month, with an above-average amount of non-storable waste, how large an incinerator would be required to burn that amount?

3. In a "worst case" winter month, how much fuel would be available to meet the large heating demands and other loads? How much additional use of conventional fuel would be necessary?

If the community can respond positively to these conditions, acquiring a system similar to that discussed in this report may prove feasible. The calculations section that follows provides a step-by-step formula in which local statistics can be inserted to help determine if further study is warranted.

VII. CALCULATIONS AND EXAMPLES

For the purpose of feasibility calculation, average conversion factors are used for fuel heating contents and efficiences. If more specific information is available from local conditions, those values should be used.

Annual Calculation

The FIRST step is to convert the annual energy consumption of the potential customer to missions of BTUs. Begin the calculation with the annual fuel use listed in a twelve month billing period. Assume in this example that the customer requires 50,000 MCF of natural gas per year to fire the boilers. Convert this to millions of BTUs (MMBTU) assuming a boiler efficiency of 74%. A combustion gas analysis of the boiler may produce a more accurate efficiency figure, which should be used if available; similarly, heating content of local fuels should be substituted if available. The power company can provide local natural gas heating value when applicable.

50,000 MCF/YEAR x 0.9 MMBTU/MCF x 0.74 eff = 33,300 MMBTU/YEAR

If the customer is using another conventional fuel, such as coal, fuel oil, or propane, the appropriate conversions for BTU per unit fuel should be used.

SECOND, convert the customer demand for MMBTUs to tons of waste needed to satisfy demand. Assume that one ton of municipal solid waste has a high heating value of 9.5 MMBTU, and that the efficiency of the incinerator will be 55%.

33,300 MMBTU/YEAR / (9.5 MMBTU/TON X 0.55 eff.) = 6,316 tons/year.

If there is no other waste available to burn, a community would need 6,316 tons of municipal solid waste per year to meet its load demand.

If wood wasge or another flammable industrial waste is available, calculate its heating value. If it may be stored it will be used in the winter when MSW runs out and before conventional fuels are used. Assume a local wood mill can provide 2,000 tons of wood waste and bark per year, with a high heating value of 18 MMBTU per ton and an incinerator efficiency of 55%.

2,000 tons x 18 MMBTU/TON x 0.55 eff. = 19,800 MMBTU/YEAR.

Convert this heat value to municipal solid waste:

19,800 MMBTU / (9.5 MMBTU/TON x 0.55 eff.) = 3,789 tons of MSW can be replaced by wood waste.

Summarizing, if 6,316 tons of municipal waste are available annually, the demand can theoretically be met without wood waste. If the 2,000 tons of wood waste are available, only 2,527 tons of MSW are needed.

Next, look at the annual flow. Municipal solid waste cannot be stored long without insect, rodent, odor, health and other problems developing. When there is an excess of municipal solid waste in the summer, it must be burned even though there is no need for the heat. Similarly, in the winter when demand for steam is high, MSW supplies are at a minimum.

Comparison of Available and Required Fuel

Month	MSW Available tons	MSW Needed tons	MSW Excess tons
January	186	1,063	
February	196	839	
March	248	786	
April	240	678	
May	279	395	
June	300	280	20
July	310	159	151
August	310	204	106
September	270	301	
October	248	443	
November	210	775	
December	186	1,035	

Winter Month Analysis

A comparison of the second and third columns shows that large quantities of additional fuel will be needed during the winter. If sufficient quantities of storable industrial waste such as bark and wood waste are not available, then conventional fuels must be used to meet the demand.

Summer Month Analysis

An examination of the last column above shows that in this example, minimum heat will be dumped during the summer. A special consideration in sizing a combustion unit is to design it so it can be used to dispose of all of the MSW and dump the heat when heat is not needed. Also, summer use may be increased by converting cooking, laundry, and other process systems to steam.

EXPLINATION OF TABLES

1982 with debt service

For the purposes of this brochure we have printed computer model results for 1982 with debt service. A brief explination of each of the columns in the set of tables follows. The key columns have been brought together in an "executive summary" of the tables. The summary includes columns 1,3,5,10,25 and 32. This summary follows the complete tables.

1. MONTH: Sum and average over the months are included in this column.

2. GAS USE WITHOUT PROJECT, MCF/MONTH: College data for 1980 was used after adjustment with National Weather Service Data for the relatively mild winter of 1980, the baseload for the college, and the addition of the new swimming pool building.

3. WMC REQUIRED TOTAL OUTPUT MMBTU/DAY: These calculations consider both the btu content of natural gas in Dillon and the tested boiler efficiency at the campus.

4. REQUIRED MSW, TONS/DAY: This is the amount of municipal solid waste which would be required to meet the campus heat demand based on assumed heat contents and efficiencies.

5. AVAILABLE MSW, TONS/DAY: This is the approximate amount currently taken to the landfill. It is assumed that all will be burned, whether heat is needed or not. The size of unit proposed will be adequate for this until the MSW available triples.

6. REQUIED WOOD WASTE, TONS/DAY: This is the wood waste required as a second preference fuel after all available garbage has been burned, in order to meet the heating load of the campus.

7. AVAILABLE WOOD WASTE, TONS/DAY: Calculations are based on a conservative ten (10) tons per day. Stoltze Lumber anticipates producing eight to sixteen tons per day.

8. USED WOOD WASTE, TONS/DAY: This is the lesser total of the previous two columns.

9. PROPORTION OF MONTH WITH THREE SHIFTS: This denotes the months when weather conditions require more than one eight hour shift to meet demands. Gas must be used as a supplimentary fuel during these periods so maintenance can usually be accomplished when the current boiler plant is carrying the load.

10. MAKE-UP NATURAL GAS MCF/MONTH: This includes both the portion of heating load which cannot be carried through MSW or wood waste, and an

auxiliary component for start-up or shutdown of operation with these primary fuels.

11. WMC COST OF DISPOSAL, DOLLARS/MONTH: This is the average current monthly cost.

12. WMC GAS COST DOLLARS/MONTH WITHOUT PROJECT: This converts the second column, gas consumption, into 1982 dollars.

13. WMC TOTAL COST WITHOUT PROJECT: The only two costs involved are for natural gas and waste disposal; therefore, this is the sum of the last two columns.

14. BEAVERHEAD COUNTY COST WITHOUT PROJECT, DOLLARS/MONTH: This is the county landfill operation cost.

15. WMC GAS COST WITHOUT PROJECT, DOLLARS/MONTH: This converts the make-up gas column into 1982 dollars.

16. WMC DISPOSAL COSTS WITH PROJECT, DOLLARS/MONTH: This is an assumed slight reduction from the "without project" monthly cost to allow for the lowered hauling costs of the campus waste.

17. TIPPING FEES, DOLLARS/MONTH A tipping fee rate of $7.00 was used, $6 to be paid by the county, $1 to be paid by the tipper. It currently costs the county about $9/ton to bury the MSW. The $1/ton paid by the tipper is in lieu of reduced hauling distance with the project in place.

18. WOOD WASTE COST TO WMC, DOLLARS/MONTH: The cited figure is $2/ton.

19. WOOD WASTE TRANSPORTATION COSTS TO WMC, DOLLARS/MONTH : It was assumed that Beaverhead County, or some alternate, would haul the wood waste the 8 mile distance for $2/ton-mile.

20. ASH TRANSPORT COST TO WMC, DOLLARS/MONTH: This figure was reached by using the relative weight of ash resulting from both the MSW and the wood waste process, the relative weight of the wet ash, the distance of the facility to the landfill, and the assumed hauling price of $2/ton-mile.

21. DEBT SERVICE COST TO WMC, DOLLARS/MONTH: A $1,000,000 note was assumed at 11% over 15 years; the usual capital recovery figure was divided for simplicity into 12 equal payments.

22. ADDITIONAL LABOR COST TO WMC, DOLLARS/MONTH: $3,000 was assumed as a conservative estimate.

23. ADDITIONAL ELECTRICITY COST TO WMC, DOLLARS/MONTH: This figure is based on an additional 14,000 KWH/month used by the facility. Several large motors are involved.

24. SPARES AND SUPPLIES COST TO WMC, DOLLARS/MONTH: As an approximation to the rule-of-thumb calling for about 5% of the debt service cost, $500 was used.

25. WMC COST WITH PROJECT, DOLLARS/MONTH: This is the sum of the previous ten columns (tipping fees to college subtracted instead of added).

26. BEAVERHEAD COUNTY NET FEES FOR WOOD WASTE HAULING, DOLLARS/MONTH: It was assumed that the county netted $0.50 of the $2.00 per ton-mile hauling fee.

27. BEAVERHEAD COUNTY NET FEES FOR ASH HAULING, DOLLARS/MONTH: Comments same as above.

28. BEAVERHEAD COUNTY COSTS FOR LANDFILL OPERATIONS WITH PROJECT, DOLLARS/MONTH: With less need to bury the MSW (Ash can be used as a cover), it was assumed that the county cost would reduce from $9/ton to $7/ton.

29. BEAVERHEAD COUNTY PORTION OF OF TIPPING FEES, DOLLARS/MONTH: As stated above, it was assumed that the county would bear $6 of the $7/ton tipping fee.

30. BEAVERHEAD COUNTY COSTS WITH PROJECT, DOLLARS/MONTH: This is the sum of the previous four columns, with the sign of the first two reversed.

31. BEAVERHEAD COUNTY COST DIFFERENCE WITH PROJECT, DOLLARS/MONTH: This is the bottom line cost to the county for having the project in place. Negative numbers imply a net benefit.

32. WMC COST DIFFERENCE WITH PROJECT IN PLACE, DOLLARS/MONTH: This is the bottom line figure for the college. Negative numbers imply a net benefit.

1 --MONTH--	2 GAS USE W/O PROJ MCF/MO	3 WMC REQ´D TOTAL OUT MMBTU/DAY	4 REQ´D MSW TONS/DAY	5 AVAIL´B´L MSW USED TONS/DAY	6 REQ´D WW TONS/DAY	7 AVAIL´B´L W WASTE TONS/DAY	8 USED W WASTE TONS/DAY	9 PROP´N MO W/3 SHFTS
JAN	8340	179	34.29	6	14.93	10	10.00	1.00
FEB	7290	157	29.98	7	12.13	10	10.00	1.00
MAR	6168	133	25.36	8	9.16	10	9.16	1.00
APR	5174	111	21.27	8	7.01	10	7.01	0.00
MAY	3100	67	12.75	9	1.98	10	1.98	0.00
JUN	2272	49	9.34	10	0.00	10	0.00	0.00
JUL	1249	27	5.14	10	0.00	10	0.00	0.00
AUG	1598	34	6.57	10	0.00	10	0.00	0.00
SEP	2438	52	10.02	9	0.54	10	0.54	0.00
OCT	3476	75	14.29	8	3.32	10	3.32	0.00
NOV	6281	135	25.83	7	9.94	10	9.94	0.50
DEC	8120	174	33.39	6	14.46	10	10.00	1.00
SUM	55506							
AVG	4626	99	19	8	5.73	10	5.16	0.38

--MONTH--	10 MAKE-UP NAT'L GAS MCF/MO	11 WMC COST DISPOSAL $/MO	12 WMC GAS W/O PROJ $/MO	13 WMC COST W/O PROJ $/MO	14 BHD COST W/O PROJ $/MO	15 WMC GAS W/PROJECT $/MO	16 WMC W/PRJ DISPOSAL $/MO	17 TIPPING FEES $/MO
JAN	2306	266	36596	36862	1260	10117	235	1260
FEB	1015	266	31989	32255	1470	4452	235	1470
MAR	35	266	27065	27331	1680	154	235	1680
APR	31	266	22704	22970	1680	135	235	1680
MAY	22	266	13603	13869	1890	99	235	1890
JUN	20	266	9970	10236	2100	90	235	2100
JUL	20	266	5481	5747	2100	90	235	2100
AUG	20	266	7012	7278	2100	90	235	2100
SEP	20	266	10698	10964	1890	86	235	1890
OCT	23	266	15253	15519	1680	102	235	1680
NOV	35	266	27561	27827	1470	152	235	1470
DEC	2086	266	35631	35897	1260	9152	235	1260
SUM	5633	3192	243560	246752	20580	24718	2820	20580
AVG	469	266	20297	20563	1715	2060	235	1715

--MONTH--	18 W WASTE COST $/MO	19 W WASTE TRANSP $/MO	20 ASH TRNSP $/MO	21 DEBT SVC $/MO	22 ADL LABOR $/MO	23 ADL ELCTY $/MO	24 SPARES & SUPPLIES $/MO	25 WMC COST W/PROJECT $/MO
JAN	600	4800	259	11589	3000	228	500	30068
FEB	600	4800	284	11589	3000	228	500	24218
MAR	550	4398	301	11589	3000	228	500	19275
APR	420	3363	277	11589	3000	228	500	18067
MAY	119	949	248	11589	3000	228	500	15077
JUN	0	0	252	11589	3000	228	500	13794
JUL	0	0	252	11589	3000	228	500	13794
AUG	0	0	252	11589	3000	228	500	13794
SEP	32	260	233	11589	3000	228	500	14272
OCT	199	1594	237	11589	3000	228	500	16005
NOV	596	4769	284	11589	3000	228	500	19884
DEC	600	4800	259	11589	3000	228	500	29103
SUM	3717	29734	3139	139065	36000	2738	6000	227351
AVG	310	2478	262	11589	3000	228	500	18946

--MONTH--	26 BHD NFEES WW HAUL'G $/MO	27 BHD NFEES ASH H'L'G $/MO	28 BHD COST LNDFL W/P $/MO	29 BHD COST TIPPING $/MO	30 BHD COST W/PROJECT $/MO	31 BHD COST DIF W/PRJ $/MO	32 WMC COST DIF W/PRJ $/MO
JAN	1200	65	216	1080	31	-1229	-6794
FEB	1200	71	237	1260	226	-1244	-8037
MAR	1100	75	250	1440	516	-1164	-8056
APR	841	69	231	1440	761	-919	-4902
MAY	237	62	207	1620	1527	-363	1208
JUN	0	63	210	1800	1947	-153	3558
JUL	0	63	210	1800	1947	-153	8047
AUG	0	63	210	1800	1947	-153	6516
SEP	65	58	194	1620	1691	-199	3308
OCT	399	59	198	1440	1180	-500	486
NOV	1192	71	236	1260	233	-1237	-7943
DEC	1200	65	216	1080	31	-1229	-6794
SUM	7433	785	2616	17640	12037	-8543	-19402
AVG	619	65	218	1470	1003	-712	-1617